V.—*On a remarkable heat observed in masses of Brine kept for some time in large reservoirs.* *By* G. A. Prinsep, *Esq.*

In the course of my experiments of several years in the manufacture of salt at *Balya Ghát*, on the salt-water lake east of Calcutta, I have sometimes observed a high degree of temperature at the bottom of the brine reservoirs after they had been filled for some weeks with brine of less than one fourth saturation. But as the greatest heat observed did not exceed 104° Fahr. which was under the maximum heat of the brine on the terraces, whence the reservoirs had been filled, I supposed the high temperature to be merely that of a warm stream of water let in at the hottest part of the day in May or June, and remaining below and unmixed with the cooler surface water, of less specific gravity, afterwards admitted. This opinion was strengthened by the gradual reduction of the temperature below to nearly that of the surface, before the end of the rainy season. I have frequently bathed in one of the reservoirs (about 550 feet long, 35 ft. wide at top and 7 or 8 feet deep), in September and October, and have found the temperature of the water then pretty equal throughout. But on plunging into the same reservoir on the 17th September last, I was surprised to find the temperature near the bottom so warm as to be intolerable to the feet. Still however I imagined that the heat was only that which the sun had imparted to the terrace brine in the very sultry weather of June last, when I had 120° registered (4th June, 4 P. M.) for the brine of a terrace yielding salt: and believing the hottest water to be therefore near the bottom I tried the temperature there about a month afterwards by immersing an empty bottle at the end of a bamboo, fixing the mouth so that it would be filled about a foot from the ground. The contents when poured out were at the temperature of 120°. A similar experiment made on the same day in a circular brine reservoir at *Narainpore* (120 feet diam. and about 16 feet deep) gave 104°. But on a subsequent visit to *Narainpore* on the 29th October, I was startled to observe that a pump fixed against the wall of this reservoir, for the purpose of feeding the boilers, was actually bringing up water of the temperature of 130° from a depth of about 12 feet. This very unexpected discovery determined me to contrive an instrument that should serve as a probe to ascertain both the temperature and the specific gravity or saltness of the water at different depths. Annexed is a drawing of the instrument employed: it consisted of a split bamboo with bamboo buckets fixed between at distances of one foot from centre to centre, the mouths of the buckets being corked but the corks having small air-holes; and the mode of using the machine was, to let it down with the mouths of the buckets downwards, and then turn it round after which the air bubbles indicated the progress

of filling and in ten minutes or a quarter of an hour, when these disappeared, the machine was quickly drawn up and the temperature of the water in the buckets was tried rapidly in succession with a small thermometer, leaving the specific gravity to be tried afterwards.

On the day of the first trial of this probe I was favored with the company and assistance of Dr. HUFFNAGLE, who took a lively interest in the experiment. The following particulars are the results of all the trials I have yet made with it, the buckets being numbered from the bottom of the machine.

First Experiment, 5th November, 9 A. M.
Open long reservoir at *Balya Ghát*,
Probe immersed at an angle of 45 or 50°.

No.	Temp.					
1	106	only ¼ full.				
2	120	S. G. (appt.)	1077	at T.	117	
3	120½	,, ,,	1073.5	,,	116½	
4	113	,, ,,	1071	,,	110	
5	99	,, ,,	1049	,,	97	
6	80	,, ,,	1022	,,	80	
7	78½	,, ,,	1022	,,	78	
8	78	,, ,,	1021	,,	78	
9	78	,, ,,	1023.5	,,	78	

Second Experiment, 5th November, 2 P. M.
at Narainpore.
Open round brine reservoir. Probe at angle about 60° southwest side.

No.	Temp.					
1	105	(appt.) S. G.	1163	at T.	100	
2	104	not full.				
3	106	(appt.) S. G.	1140	,,	104	
4	113	,, ,,	1160	,,	108	
5	117	,, ,,	1161	,,	113	
6	123	,, ,,	1157	,,	117	
7	130	,, ,,	1159	,,	123	
8	132	,, ,,	1153.5	,,	124	
9	137	,, ,,	1145	,,	130	
10	131	,, ,,	1121	,,	125	
11	127	,, ,,	1100	,,	120	
12	122	,, ,,	1090	,,	114	
13	114	,, ,,	1075	,,	109	
14	104	,, ,,	1065	,,	101	
15	100	,, ,,	1065	,,	97	
16	85	,, ,,	1040	,,	84	
17	84	,, ,,	1044.3	,,	83	
18	82	,, ,,	not full.			
19	82	,, ,,	1038	,,	81	

Third Experiment, 5th November, 2½ P. M.
Same place and reservoir east side at gate. Probe at angle about 75°.

No.	Temp.					
1	102	(appt.) S. G.	1149	at T.	100	
2	106	,, ,,	1145.3	,,	103	
3	109	,, not full.				
4	114	,, S. G.	1175	,,	111	
5	119	,, ,,	1165.5	,,	116	
6	128	,, ,,	1159	,,	124	
7	137	,, ,,	1155	,,	130	
8	133	,, ,,	1139	,,	128	
9	135	,, ,,	1125	,,	127	
10	127	,, ,,	1097	,,	120	
11	114	,, ,,	1075	,,	109	
12	105	,, ,,	1068	,,	101	
13	92	,, ,,	1050	,,	90	
14	86	,, ,,	1040	,,	84	
15	82½	,, ,,	1038	,,	81	
16	81½	,, ,,	1037½	,,	81	

Fourth Experiment, 19th November, 2 P. M.
at Narainpore.
Open round brine reservoir southwest side. Probe at angle 60°.

No.	Temp.					
1	104	(appt.) S. G.	1150	at T.	102	
2	108	,, not full.				
3	108½	,, S. G.	1150	,,	106	
4	114	,, ,,	1148	,,	112	
5	125	,, ,,	1166	,,	120	
6	132	,, ,,	1151	,,	124	
7	136	,, ,,	1142	,,	127	
8	133	,, ,,	1126	,,	128	
9	127	,, ,,	1095	,,	120	
10	124	,, ,,	1070	,,	110	
11	117	,, ,,	1061	,,	104	
12	99	,, ,,	1057	,,	96	
13	90	,, ,,	1047	,,	90	
14	83	,, ,,	1046	,,	83	
15	81½	,, ,,	1045.6	,,	83	
16	81	,, ,,	1045	,,	83	
17	82	,, ,,	1045	,,	83	

Fifth Experiment, same date and place.
Covered reservoir. Probe at angle about 70°.

No.	Temp.		
1	88	(appt.) S. G.	1147
2	88	,, ,,	1124.5
3	90	,, ,,	1107
4	91	,, ,,	1107
5	90	,, ,,	1102.6
6	90	,, ,,	1094
7	89	,, ,,	1081
8	88	,, ,,	1078
9	87½	,, ,,	1069
10	—	empty.	
11	82	,, ,,	1054
12	80	} not full.	
13	77		
14	76		1046
15	76		1046

Sixth Experiment, same date and place.
Large reservoir. Probe at angle about 80°. Tried at 2½ P. M.

No.	Temp.			
1	93½	(appt.) S. G.	,,	1070
2	93½	,, ,,	,,	1070
3	93	,, ,,	,,	1069
4	92	,, ,,	,,	1067
5	91½	,, ,,	,,	1064
6	90	,, ,,	,,	1061.5
7	87	,, ,,	,,	1057
8	85	,, ,,	,,	1056
9	84	,, ,,	,,	1050
10	84	,, ,,	,,	1050.5
11	84	(not full).		
12	84	,, ,,	,,	1050

Seventh Experiment, 3rd December, 2 P. M. at Narainpore.

Open round reservoir, tried in the centre, probe nearly perpendicular.

No. 1	T. 107	half full.		
2	110	apparent S. G.	1151	at T. 106
3	114	,,	1150	,, 110
4	118	,,	1143.5	,, 118
5	125	half full.		
6	124	,,	1114	,, 116
7	116	,,	1095	,, 112
8	105	,,	1078.5	,, 103
9	96	,,	1063.5	,, 93
10	92	,,	1059	,, 90
11	87	,,	1054	
12	86	,,	1053.7	
13	84	half full.		
14	82	,,	1052	
15	81	,,	1053	
16	82	,,	1052	
17	82	,,	1051	

In the first trial at *Narainpore* the greatest heat was found about halfway from the bottom. The difference in that respect at *Balya Ghát* where the greatest heat appeared at the second and third foot from the bottom may be explained, by the small depth of the reservoir at the latter place, the surface water being liable to be affected to the same depth in both by the wind and rain and temperature of the atmosphere, and the subsequent descent of the maximum heat at *Narainpore* is attributable in part to the expenditure of the brine there being pumped out from near the bottom for the supply of the boilers. The highest temperature given by the probe at *Narainpore* was 137°, but this is 5° less than the maximum given by the pumps, as will be seen by the following statement.

29	Oct.	N. pump	T. 130	S. G. (corrected)	1180					
12	Nov.	,, ,,	,, 138	,, ,,	1170					
19	,,	,, ,,	,, 142	,, ,,	1162					
26	,,	,, ,,	,, 140½	,, ,,	1152					
3	Dec.	,, ,,	,, 137	,, ,,	1133	S. Pump	134	S. G.	1172	
10	,,	,, ,,	,, 124	,, ,,	1173	,,	124	,,	1158	
17	,,	,, ,,	,, 125	,, ,,	1153	,,	124	,,	1175	
24	,,	,, ,,	,, 119	,, ,,	1173	,,	116	,,	1171	
31	,,	,, ,,	,, 116	,, ,,	1174	,,	114	,,	1179	
7	Jan.	,, ,,	,, 102	,, ,,	1133	,,	106	,,	1128	
13	,,	(sunk 2 feet)	104	,, ,,	1177	,,	100	,,	1132	
4	Feb.		90½	,, ,,	1100	,,	92	,,	1119	
10	,,	.....	.....	.....	.....	,,	90	,,	1110	

As the temperature of 90° was only about the mean of June, and also that of the lower moiety of the brine in the covered reservoir on the 19th November, which was all nearly of an equable temperature, I consider the influence of the heating course to have ceased in the first week of February, if not before. The reservoirs have since been pumped dry and therefore these experiments cannot be repeated, until they are replenished with brine in April or May next.

It is remarkable that the probe indicated no signs of a heating influence affecting the water in the large reservoir at *Narainpore* on the 19th November though the specific gravity of the brine near the bottom was little less than that of the water in the long reservoir at *Balya Ghát* on the 5th November, its mean spec. grav. being also considerably higher than the mean of the latter. Moreover the heating influence was scarcely traceable in the covered brine reservoir at *Narainpore* on the 19th November, which perhaps may be accounted for by the large previous expenditure of brine, say about three-fourths of its original contents, the consumption of which had been replaced to within a foot of the general level by filtration from the ground and leakage at the gate communicating with the adjoining terrace and brine fields; whereas the expenditure of brine in the contiguous open round reservoir otherwise similarly situated, was but half of the original contents up to the middle of January, its entire volume being about 170,000 cubic feet, while the covered reservoir contained only about 50,000. In these two reservoirs all the brine when first let in was of a high degree of saturation, ranging from 1170 to 1200 sp. gr. and consequently containing little or no sulphate of lime, which ingredient in the composition of sea water, I have observed at *Balya Ghát*, is always deposited upon the terraces there, considerably before the brine begins to deposit its sulphate of soda. But this was not the case with respect to the brine in the large reservoir at *Narainpore*, nor in that of a longer narrow one at *Balya Ghát*, except perhaps a small proportion of the latter, both of which were charged with brine of only 1070 to 1085 sp. gr., a much higher degree however than that of the contents of the long reservoir in any previous year; and in both of them the water had remained undisturbed, except by the action of the atmosphere ; yet in one of them a high degree of heat was observed, and in the other where I should sooner have expected to find it, no indication of heat was perceived beyond the probable temperature at which it was filled in June.

In order to ascertain however whether any fermentation and disengagement of heat takes place on the mixture of saturated brine with brine of a weaker degree, I lately procured from *Balya Ghát* some bottles of brine of different degrees of saturation, with which the following experiments were tried.

1*st Experiment.*—Half a pint of saturated brine sp. gr. 1216, temperature 82.5 mixed with about the same quantity of brine of sp. gr. 1069, temperature 81.2. Result, temperature 82.2 and no effervescence after standing some minutes.

2*nd Experiment.*—Same quantities of brine sp. gr. 1216, tempera-

ture 82.5, and of brine sp. gr. 1091, temperature 81°. Result, sp. gr. 1152.5, temperature 82.2 and no effervescence.

3rd Experiment.—Same quantities of brine sp. gr. 1216, temperature 82.5, and sp. gr. 1135, temperature 81.6. Result, sp. gr. 1174.3, temperature 82.1 and no effervescence, nor any increase of temperature after remaining some hours in the glass.

Being therefore quite unable to offer any explanation of the cause of the remarkable heat observed in my brine reservoirs, I can only promise to register the temperature from time to time when they are filled again in the hope that materials may thus be furnished to some scientific friend more capable of solving the interesting problem. If it should be discovered that a slow fermentation arising from the mixture of brine of different densities in large masses is the cause of this heat, it would seem to be accelerated by agitation, for the water raised by the pumps was always warmer than that which the probe brought up from the same depth; and, except at the first trial at *Narainpore*, always hotter than the maximum given by the probe.

VI.—*On the Land and Fresh-water Shells of the Western Himálaya.* *By Lieut.* T. Hutton, *37th Regt. N. I. and* W. H. Benson, *Esq., C. S.*

The following catalogue chiefly refers to shells which I have lately discovered, almost all inhabiting the western portion of the *Himálaya* in the neighbourhood of *Simla*, and extending upwards from *Monimajra* at the extreme verge of the hills, to the *Burenda Pass* on the Snowy range. In the description of the various species, I have availed myself of the valuable assistance of Mr. Benson, C. S. whose extensive collection of terrestrial and fluviatile shells from all parts of the world, and whose greater experience in this branch of natural history, have enabled him to do more justice to the subject, than I could have done without assistance. In order, however, that each may in some measure stand responsible for his contributions, an initial letter will be found affixed.

Although most of the shells belong to the hills, a few were collected on the route from *Neemuch* in the cold season of 1835-6.—"The most interesting of these acquisitions is an unique specimen of an '*Ancylus*' the first of this Patelliform genus yet discovered in India, if not in Asia*." It occurred adhering to a dead specimen of *Paludina Bengalensis*, in the *Kali Nuddí* at *Bolund Shehr*.

* Benson.